# Recent accomplishments of the US CLIVAR MJO Working Group (MJOWG)

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In spring 2006, US CLIVAR established the Madden-Julian Oscillation (MJO) Working Group (MJOWG; http://www.usclivar.org/mjo.php). The formation of this roughly 2-year limited lifetime WG was motivated by: 1) the wide range of weather and climate phenomena that the MJO interacts with and influences, 2) the fact that the MJO represents an important, and as yet unexploited, source of predictability at the subseasonal time scale, 3) the considerable shortcomings in our global climate and forecast models in representing the MJO, and 4) the need for coordinating the multiple threads of programmatic and investigator level research on the MJO. MJOWG tasks have involved the development of diagnostics for assessing model performance in both climate simulation and extended-range/subseasonal forecast settings as well as the development of a consistent and coordinated approach to subseasonal, specifically MJO, forecasting. The purpose of this newsletter item is to make the readers aware of these activities. The items below highlight the main activities of this working group.

## MJO Simulation Diagnostics

The Madden-Julian Oscillation (MJO) interacts with, and influences, a wide range of weather and climate phenomena (e.g., monsoons, ENSO, tropical storms, mid-latitude weather), and represents an important, and as yet unexploited, source of predictability at the subseasonal time scale. Despite the important role of the MJO in our climate and weather systems, current global circulation models (GCMs) exhibit considerable shortcomings in representing it. These shortcomings have been documented in a number of multi-model comparison studies over the last decade. However, diagnosis of model performance has been challenging, and model progress has been difficult to track, due to the lack of a coherent and standardized set of MJO diagnostics. A chief objective of the US CLIVAR MJO Working Group is the development of diagnostics for objectively evaluating global model simulations of the MJO. Motivation for this activity is reviewed, and the intent and justification for a set of diagnostics is provided, along with specification for their calculation, and illustrations of their application. The diagnostics range from relatively simple analyses of variance and correlation diagnostics, to more sophisticated space-time spectral analyses and computation of empirical orthogonal functions. These diagnostic techniques are used to construct composite life-cycles, to identify associations of MJO activity with the mean state, and to describe interannual variability of the MJO. A link to the diagnostics are posted on the MJOWG web site (or see direct link at: http://climate.snu.ac.kr/mjo_diagnostics/index.htm) and a journal article has been submitted that describes this effort. See US CLIVAR Madden-Julian Oscillation Working Group, 2008: MJO Simulation Diagnostics, *J. Clim.*, Submitted.

## Application of MJO Simulation Diagnostics to Climate Models

The ability of 8 climate models to simulate the Madden-Julian Oscillation (MJO) has been examined using recently developed diagnostics for MJO simulation. This study focuses on the boreal wintertime (November-April). The mean state, variance map and equatorial space-time

spectra of 850hPa zonal wind and precipitation are compared with observations. Although many of participating model have stronger sub-seasonal variability of precipitation, only one model produces dominant spectral peak in the MJO space-time scale as in observation. It is revealed that the MJO signal from large-scale circulation (850hPa zonal wind) is better than that of latent heating (rainfall) in most of the models. Multivariate empirical orthogonal function (EOF) method is suggested as useful tool to extract model's own MJO-like phenomenon and it is compared with single variable EOF analysis. By compositing on the phase and amplitude of the two leading principal components, the decay time scale of canonical strong MJO events is assessed for different initial phases of the in the MJO life-cycle. The MJO decay (e-folding) time scale depends on initial phase and all models have shorter period (~23-29days) compared to observation (~31days). The important features - surface latent heat flux, boundary layer (925hPa) moisture convergence and vertical structure of moisture - associated with the model's MJO are investigated. Frictional moisture convergence ahead (east) of convection seems to be a mechanism of eastward propagation in most of the models, supporting to current paradigm. Some models are able to reproduce the observed geographical difference in vertical structure of moisture associated with the MJO. Also examined in this effort are the characteristics of the models' precipitation dependence on lower tropospheric relative humidity and fraction of stratiform rainfall, and the implications on the fidelity of the MJO simulation. A journal article is being prepared that describes this effort (contact: kim@climate.snu.ac.kr; Kim et al., 2008: Application of MJO Simulation Diagnostics to Climate Models, *J. Clim.*, In Preparation)

**MJO Workshop: New Approaches to Understanding, Simulating, and Forecasting the Madden-Julian Oscillation**

Through the sponsorship of US CLIVAR and International CLIVAR, the MJOWG hosted an invitation-only workshop that gathered researchers and forecasters of the Madden-Julian Oscillation to discuss new approaches to understanding, simulating, and forecasting the MJO in the context of weather-climate connections. The workshop was held November 5-7, 2007, in Irvine, CA. The workshop was attended by members of both the MJO research and forecasting communities. Its objectives included: (1) Introducing new diagnostics designed to systematically evaluate model simulations and forecasts of the MJO; (2) Identifying key limits to our understanding of the MJO as well as to the processes that might be crucial for modeling the MJO; and (3) Developing integrative approaches to tackle the problems associated with understanding, simulating, and forecasting the MJO. The workshop was organized into six half-day sessions over three days. The first day emphasized diagnostics and models, and forecast metrics. The second day focused on vertical and multi-scale structures, as well as theory and modeling. The theme of the third day was integrative modeling approaches with sessions on existing and planned efforts, and new initiatives and next steps. Each session included three invited talks, a poster session, and a one-hour discussion. Most of the oral and poster presentations can be found at: http://www.joss.ucar.edu/joss_psg/meetings/Meetings_2007/MJO/index.html, and a meeting summary is in press with the Bulletin of the Meteorological Society (BAMS), with an Early Online Release version available at: http://ams.allenpress.com/archive/1520-0477/preprint/2008/pdf/10.1175_2008BAMS2700.1.pdf.

**Operational Forecasting of the MJO**

The development and operational implementation of an MJO forecast metric is a key goal of the MJOWG. We have developed a version of the Wheeler & Hendon combined EOF that is being applied operationally, in a coordinated manner, to a number of forecast centers' extended-range forecasts and their ensembles. Participation in this activity, through its development phase, has been from ECMWF, UKMO, CMA, BMRC, and NCEP. We recently received endorsement for this activity from the Working Group on Numerical Experimentation (WGNE), and through collaboration with WGNE, are formally establishing this methodology and inviting wider participation from other international forecast centers. Based on this invitation, JMA and CPTEC have also become participants. At this time, the centers are sending their MJO forecast metric data to CPC/NOAA for uniform, real-time web presentation and potential use and development of a multi-model ensemble prediction of the MJO (contact Jon.Gottschalck@noaa.gov for details). More information on this effort can be found in an article in the next CLIVAR Exchanges (October 2008; http://www.clivar.org/publications/exchanges/exchanges.php), and a journal article is being prepared for BAMS.

To more formally assess the MJO skill of the operational forecasting effort, we are considering the development of hindcast experiments. These experiments would provide valuable information with respect to MJO predictability from different phases of the MJO life-cycle, as well as the MJO's associated impacts on other weather/climate phenomena. Additionally, it is possible that select MJO hindcast periods could be adopted as benchmark tests for model development by the numerical weather prediction community. Also under consideration is the development of a forecast metric that is more specific to the boreal summer Asian monsoon domain, so as to better capture the northward propagating intraseasonal convective signal that affects India and southeast Asia.